CLAIMS

What is claimed is:

1. A method of making a machinable austempered cast iron article from an iron composition having a substantially pearlitic microstructure that includes carbon, silicon, nickel, copper, and molybdenum, said method comprising the steps of:

austenitizing the substantially pearlitic microstructure in an intercritical temperature range of from 1380°F to 1500°F for a period of at least 10 minutes to produce a ferritic plus austenitic microstructure;

quenching the ferritic plus austenitic microstructure at a rate sufficient to prevent formation of pearlite;

austempering the ferritic plus austenitic microstructure in an austempering temperature range of from 575°F to 750°F for a period of at least 8 minutes to produce a microstructure of a continuous matrix of equiaxed ferrite with islands of austenite; and

cooling the microstructure of the continuous matrix of equiaxed ferrite with islands of austenite to ambient temperature to produce the machinable austempered cast iron article having improved strength, ductility, machinability, fatigue performance, and resistance to environmental cracking.

2. A method according to claim 1 further comprising the step of casting the iron composition to produce the substantially pearlitic microstructure having at least 80% pearlite prior to austenitizing.

3. A method according to claim 1 wherein the step of austenitizing the substantially pearlitic microstructure is further defined as austenitizing the substantially pearlitic microstructure in an intercritical temperature range of from 1380°F to 1472°F.

4. A method according to claim 1 wherein the step of austenitizing the substantially pearlitic microstructure is further defined as austenitizing the substantially pearlitic microstructure in an intercritical temperature range of from 1380°F to 1449°F.

5. A method according to claim 1 wherein the step of austenitizing the substantially pearlitic microstructure is further defined as austenitizing the substantially pearlitic microstructure for a period of from 10 to 360 minutes.

6. A method according to claim 1 wherein the step of austempering the ferritic plus austenitic microstructure is further defined as austempering the ferritic plus austenitic microstructure for a period of from 8 to 1440 minutes.

7. A method according to claim 6 wherein the step of austempering the ferritic plus austenitic microstructure is further defined as austempering the ferritic plus austenitic microstructure for a period of from 60 minutes to 180 minutes.

8. A method according to claim 1 wherein the step of quenching the ferritic plus austenitic microstructure is further defined as quenching the ferritic plus austenitic microstructure into the austempering temperature range of from 575°F to 750°F within a period of from 5 to 180 seconds to prevent the formation of pearlite.

9. A method according to claim 1 wherein the step of quenching the ferritic plus austenitic microstructure is further defined as quenching the ferritic plus austenitic microstructure into the austempering temperature range in a salt bath.

10. A method according to claim 9 wherein the salt bath comprises at least one of nitrate salts, nitrite salts, and combinations thereof.

11. A method according to claim 1 wherein the step of quenching the ferritic plus austenitic microstructure is further defined as quenching the ferritic plus austenitic microstructure into the austempering temperature range in a fluidized bed.

12. A method according to claim 1 wherein the step of cooling the microstructure of the continuous matrix of equiaxed ferrite with islands of austenite to ambient temperature is further defined as cooling the microstructure of the continuous matrix of equiaxed ferrite with islands of austenite to ambient temperature in at least one of air, oil, and water.

13. A method according to claim 1 wherein the machinable austempered cast iron article is a crankshaft component.

14. A method according to claim 1 wherein the machinable austempered cast iron article is a chassis component.

15. A method of making a machinable austempered cast iron article from an iron composition that includes carbon, silicon, nickel, copper, and molybdenum, said method comprising the steps of:

casting the iron composition at a temperature of greater than 2200°F;

cooling the iron composition to a temperature of from 1000°F to 1340°F;

holding the iron composition at the temperature of from 1000°F to 1340°F for at least 8 seconds to produce a substantially pearlitic microstructure;

cooling the iron composition to an ambient temperature;

austenitizing the substantially pearlitic microstructure in an intercritical temperature range of from 1380°F to 1500°F for a period of at least 10 minutes to produce a ferritic plus austenitic microstructure;

quenching the ferritic plus austenitic microstructure at a rate sufficient to prevent formation of pearlite;

austempering the ferritic plus austenitic microstructure in an austempering temperature range of from 575°F to 750°F for a period of at least 8 minutes to produce a microstructure of a continuous matrix of equiaxed ferrite with islands of austenite; and

cooling the microstructure of the continuous matrix of equiaxed ferrite with islands of austenite to ambient temperature to produce the machinable austempered cast iron article having improved strength, machinability, fatigue performance, and resistance to environmental cracking.

16. A method according to claim 15 wherein the step of austenitizing the substantially pearlitic microstructure is further defined as austenitizing the substantially pearlitic microstructure having at least 80% pearlite in an intercritical temperature range of from 1380°F to 1472°F.

17. A method according to claim 15 wherein the step of austenitizing the substantially pearlitic microstructure is further defined as austenitizing the substantially pearlitic microstructure having at least 80% pearlite in an intercritical temperature range of from 1380°F to 1449°F.

18. A method according to claim 15 wherein the step of austenitizing the substantially pearlitic microstructure is further defined as austenitizing the substantially pearlitic microstructure for a period of from 10 to 360 minutes.

19. A method according to claim 15 wherein the step of austempering the ferritic plus austenitic microstructure is further defined as austempering the ferritic plus austenitic microstructure for a period of from 8 to 1440 minutes.

20. A method according to claim 19 wherein the step of austempering the ferritic plus austenitic microstructure is further defined as austempering the ferritic plus austenitic microstructure for a period of from 60 minutes to 180 minutes.

21. A method according to claim 15 wherein the step of quenching the ferritic plus austenitic microstructure is further defined as quenching the ferritic plus austenitic microstructure into the austempering temperature range of from 575°F to 750°F within a period of from 5 to 180 seconds to prevent the formation of pearlite.

22. A method according to claim 15 wherein the step of quenching the ferritic plus austenitic microstructure is further defined as quenching the ferritic plus austenitic microstructure into the austempering temperature range in a salt bath.

23. A method according to claim 22 wherein the salt bath comprises at least one of nitrate salts, nitrite salts, and combinations thereof.

24. A method according to claim 15 wherein the step of quenching the ferritic plus austenitic microstructure is further defined as quenching the ferritic plus austenitic microstructure into the austempering temperature range in a fluidized bed.

25. A method according to claim 15 wherein the step of cooling the microstructure of the continuous matrix of equiaxed ferrite with islands of austenite to ambient temperature is further defined as cooling the microstructure of the continuous matrix of equiaxed ferrite with islands of austenite to ambient temperature in at least one of air, oil, and water.

26. A method according to claim 15 wherein the machinable austempered cast iron article is a crankshaft component.

27. A method according to claim 15 wherein the machinable austempered cast iron article is a chassis component.

28. A machinable austempered cast iron article, said article made by the steps of:

austenitizing an iron composition having a substantially pearlitic microstructure in an intercritical temperature range of from 1380°F to 1500°F for a period of at least 10 minutes to produce a ferritic plus austenitic microstructure;

quenching the ferritic plus austenitic microstructure at a rate sufficient to prevent the formation of pearlite;

austempering said ferritic plus austenitic microstructure in an austempering temperature range of from 575°F to 750°F for a period of at least 8 minutes to produce a microstructure of a continuous matrix of equiaxed ferrite with islands of austenite; and

cooling said microstructure of said continuous matrix of equiaxed ferrite with islands of austenite to ambient temperature to produce said machinable austempered cast iron article having improved strength, machinability, ductility, fatigue performance, and resistance to environmental cracking.

29. A machinable austempered cast iron article as set forth in claim 28 wherein said substantially pearlitic microstructure includes at least 80% pearlite.

30. A machinable austempered cast iron article as set forth in claim 28 comprising, by weight, 3.3-3.9% carbon, 1.90-2.70% silicon, 0.45-2.05% nickel, 0.55-1.05% copper, 0-0.20% molybdenum, and a remainder of iron.

31. A machinable austempered cast iron article as set forth in claim 30 wherein said article has a Brinell hardness of between 180 and 340 BHN.

32. A machinable austempered cast iron article as set forth in claim 31 wherein said article has a yield strength of between 50,000 and 125,000 psi.

33. A machinable austempered cast iron article as set forth in claim 32 wherein said article has an ultimate tensile strength of between 70,000 and 170,000 psi.

34. A machinable austempered cast iron article as set forth in claim 33 wherein said article has an elongation of between 14% and 22%.

35. A machinable austempered cast iron composition, said composition comprising, by weight, 3.3-3.9% carbon, 1.90-2.70% silicon, 0.45-2.05% nickel, 0.55-1.05% copper, 0-0.20% molybdenum, and a remainder of iron, said composition characterized by a microstructure of a continuous matrix of equiaxed ferrite with islands of austenite to provide said composition with improved strength, machinability, ductility, fatigue performance, and resistance to environmental cracking.

36. A machinable austempered cast iron composition as set forth in claim 35 comprising, by weight, 3.7% carbon, 2.5% silicon, 1.85% nickel, 0.85% copper, 0.05% molybdenum, and a remainder of iron.